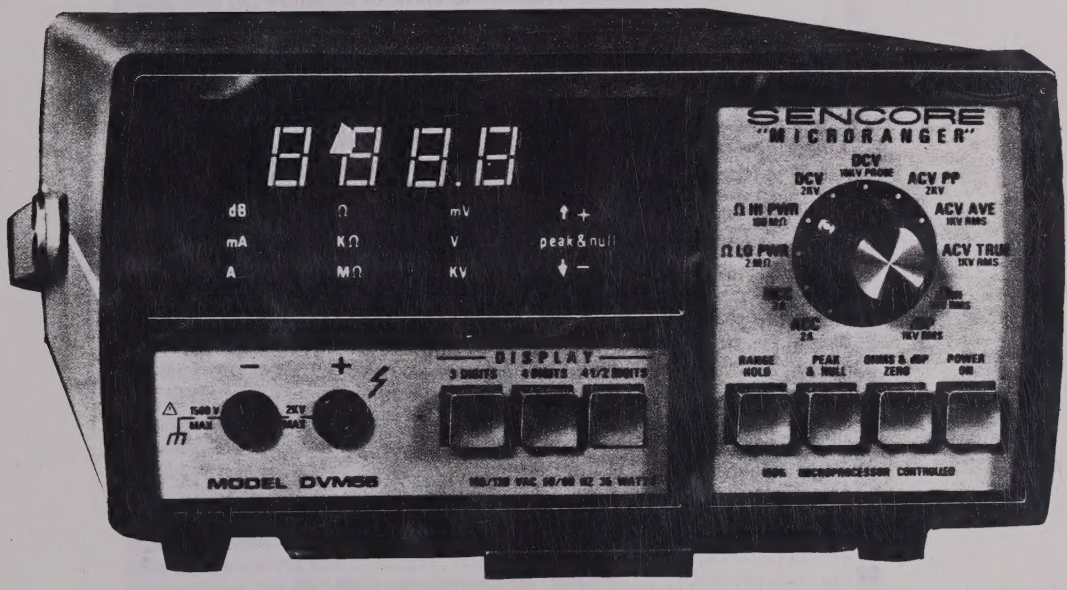
MODEL DVM56A
S/N 3441506M
REC'D. 85-12-19
PURCHASED FOR CASH

DVM56
"MICRORANGER"
DIGITAL MULTIMETER

Operation and Applications Manual

TECH. SUP.
1-800-843-3338 X 305
RALPH



GENERAL ELECTRIC
INSTRUMENTATION & COMMUNICATION
1200 KONA DRIVE
COMPTON, CA 90220

SENCORE
3200 Sencore Drive, Sioux Falls, SD 57107 (605) 339-0100

Electronic Services - Los Angeles
M14949X

TABLE OF CONTENTS

SAFETY PRECAUTIONS ..... **Inside Front Cover**

DESCRIPTION
- Introduction 4
- Features 4
- Specifications 4
- Accessories 5
- Controls 8

OPERATION
- Introduction 10
- Power Connection 10
- Power Outages 10
- Fuse Replacement 10
  - Current Fuses 10
  - Ohms Fuses 11
  - Blown Fuse Indication 11
  - Checking the Protection Fuses 11
- Autoranging "Thinking" Time 11
- Measuring DC Volts to 2 KV 12
- Measuring DC Voltages to 10 KV or in High Impedance Circuits with the TP222 Transient Protector Probe 12
- Measuring DC Voltages to 50 KV with the Optional HP200 Probe 13
- **Measuring AC Voltages**
  - Auto Zero on AC Voltage Functions 14
  - Measuring AC Volts Average RMS 14
  - Measuring AC Volts True RMS 14
  - Measuring AC Volts Peak-to-Peak 15
- Measuring dB Referenced to 600 Ohms 16
- Using the Programmable dB Function 17
- Measuring Low Level Signals with the Optional DBA220 Low Level X10 AC Amplifier 18
- **Measuring Resistance**
  - Deciding Whether to Use Hi or Lo Power Ohms 18
  - Measuring Resistance with Lo Power Ohms 19
  - Measuring Resistance with Hi Power Ohms 19
- Measuring AC and DC Current to 2 Amps 20
- Measuring AC or DC Current to 20 Amps with the Optional CS223 Shunt 21
- Making Peaking or Nulling Adjustments 21
- Using the RANGE HOLD Function 22
- Display Resolution 23
- Decimal Point Shift 23
- Overrange Indication 23
- Connecting the DVM56 Common Above Ground 23
- Test Leads 23

APPLICATIONS

AC Voltage Measurements 24
Peak-to-Peak, RMS, and Average Comparison Chart 24
Which Type of Measurement Should Your Use 25
Measuring Resistors Above 100 Megohms with the DVM56 25
Using the Programmable dBP Function in Audio Amplifiers 25
Checking Transistors and Diodes 26

SERVICE AND WARRANTY ..... Inside Back Cover

DESCRIPTION

INTRODUCTION

The use of electronics in consumer and industrial products has increased considerably in just the past two years. This increase has brought about the need for more and faster service on these elaborate circuits. The demands on the test equipment needed to service this increase of electronics has also increased where more accurate, easier to use instruments are now needed.

The Sencore DVM56 "MICRORANGER" DVM was designed to meet this increasing need for the technician and the engineer. The DVM56 is microprocessor-controlled so there are no range switches to select, no readings to interpolate or guessing where the decimal point should go. The DVM56 does it all for you automatically. The DVM56 microprocessor controls all the digital logic inside the instrument and even selects the correct range so you will always know the magnitude as well as the quantity you are measuring. You can't fool the DVM56.

FEATURES

The DVM56 "MICRORANGER" is truly a complete meter, featuring all the measurement functions that are necessary in today's modern electronic circuits. These include: DC volts to 10 KV, AC volts Average, AC volts True RMS to 1 KV, AC volts Peak-to-Peak to 2 KV, dB from -43 to +62 dB, a programmable dB, AC current, DC current to 2 amps. Hi Power ohms to 100 megohms, and Lo Power ohms to 2 megohms. You also have a choice of display resolution of 4½, 4, or 3 digits by simply pushing a button.

The TP222 10 KV transient probe, supplied with the DVM56, extends the measuring range and input protection to a full 10 KV and protects the meter against high voltage transients. A special OHMS & dBP ZERO button cancels out the test lead resistance for accurate resistance checks of very low value resistors. The same button also allows you to program into the dBP function, any 0 dB reference that is required in your testing. The RANGE HOLD button allows you to "lock" the DVM56 into any range so that a series of measurements can be made without reducing the meter response time to speed up servicing and engineering test time.

The new and unique Peak & Null circuit in the DVM56 eliminates the need for a separate analog meter. There are two LEDs that light up to indicate the direction of the change of the voltage, current, or resistance. The LEDs will show the peak or null of the measured quantity, even before a conventional d'Arsonval type meter can respond. This allows you to peak or null traps, peak currents, or similar measurements faster and easier than ever before. This makes the DVM56 the complete meter for the engineer or technician or anyone in electronics.

SPECIFICATIONS

DC VOLTS: Four automatic ranges: 0.1 mV to 1.9999 V, 2.000 V to 19.999 V, 20.00 V to 199.99 V and 200.0 V to 1.9999 KV.
Accuracy: 0.075% ±5 digits on all ranges.
Range for Stated Accuracy: 100% to 0% of range.
Input Impedance: 15 megohms.
Polarity: Automatic and indicated by negative sign (-) when input is negative with respects to + input jack.
Response Time: Less than 2 seconds maximum, including autoranging.
Maximum Input protection: 2000 volts (DC + Peak AC) on all ranges.
Normal Mode Rejection (AC rejection on DC reading): Greater than 60 dB at 50 to 60 Hertz.
Common Mode Rejection (1K ohm unbalanced): Greater than 100 dB at DC to 10 KHz.
Maximum Common Mode Voltage: 1500 volts (Peak AC + DC) between negative lead and third wire ground (case).

DC VOLTS WITH X10 ISOLATION PROBE (TP222): Four automatic ranges, 1 mV to 19.999 V, 20.00 V to 199.99 V, 200.0 V to 1999.9 V and 2.000 KV to 9.999 KV.
Accuracy: 0.5% ±5 digits on all ranges, ±100 PPM/volt, ±100 PPM/C°.
Input Impedance: 150 megohms.
Decimal Point: Automatically placed with Function switch in the DC 10 KV PROBE position.
Maximum Input Protection: 10 KV (DC + Peak AC).

AC VOLTS RMS AVERAGE: Three automatic ranges. 0.001 V to 19.999 V, 20.00 V to 199.99 V and 200.0 V to 999.9 V.
Accuracy: 0.5%, ±4 digits on all ranges at 60 Hertz.
Range Accuracy: Accurate from 100% to 5% of range.
Input Impedance: 1.0 megohm shunted by less than 40 picofarads.
AC Converter: Average detecting, calibrated to RMS 60 Hertz sine wave.
Frequency Response: 30 Hz to 20 KHz, ±1 dB, typical.
Response Time: Less than 2 seconds maximum, including autoranging.
Maximum Input Protection: 2000 volts (Peak AC + DC) or 1400 volts RMS on all ranges.
Common Mode Rejection Ratio (CMRR) 1 K ohm unbalanced: Greater than 60 dB at 60 Hertz.

AC VOLTS TRUE RMS: Three automatic ranges, 0.001 V to 19.999 V, 20.00 V to 199.99 V and 200.0 V to 999.9 V.
Accuracy: 0.5%, ±4 digits on all ranges at 60 Hertz.
Range for Stated Accuracy: 100% to 5% of range.
Input Impedance: 1.0 megohms shunted by less than 40 picofarads.
AC Converter: AC coupled true RMS, with a crest factor of 3 minimum, calibrated to 60 Hertz sine wave.
Frequency Response: 30 Hz to 20 KHz, ±1 dB typical.
Response Time: Less than 2 seconds maximum, including autoranging.
Maximum Input Protection: 2000 volts (Peak AC + DC) or 1400 volts RMS on all ranges.
Common Mode Rejection Ratio (CMRR) 1 K ohm unbalanced: Greater than 60 dB at 60 Hertz.

AC VOLTS PEAK-TO-PEAK: Three automatic ranges, 0.001 V to 19.999 V, 20.00 V to 199.99 V and 200.0 V to 1.9999 KV.
Accuracy: 1.0%, ±4 digits on all ranges at 60 Hertz.
Range for Stated Accuracy: 100% to 5% of range.
Input Impedance: 1.0 megohms shunted by less than 40 picofarads.
AC Converter: Peak detecting, calibrated to peak-to-peak reading at 60 Hz.
Frequency Response: 30 Hz to 100 KHz ±1 dB, -3 dB to 200 KHz typical. See typical frequency response curves.
Response Time: Less than 2 seconds maximum, including autoranging.
Maximum Input Protection: 2000 volts (Peak AC + DC) or 1400 volts RMS on all ranges.
Common Mode Rejection Ratio (CMRR) 1 K ohms unbalanced: Greater than 60 dB at 60 Hertz.

TRUE RMS IN dB: Three automatic ranges, -43 dBm to +28.2 dBm, +28.3 dBm to 48.2 dBm and +48.3 dBm to +62.2 dBm.
Accuracy: ±1 dB ± accuracy of True RMS ranges.

dB Reference: 1 mW into 600 ohms (0.7746 volts RMS) or a programmable reference in the dBP function switch position of any value selected by the user.
Frequency response: 30 Hz to 20 KHz, ±1 dB typical.
Input Impedance: 1.0 megohms shunted by less than 40 picofarads.
Maximum Input Protection: 2000 volts (Peak AC + DC) or 1400 volts RMS on all ranges.
Common Mode Rejection Ratio (CMRR) 1 K ohm unbalanced: Greater than 60 dB at 60 Hz.

CURRENT, AC AND DC: Two automatic ranges, 0.001 mA to 19.999 mA and 20.00 mA to 1.9999 Amps.
Accuracy: 0.3%, ±4 digits on DC and 1.0%, ±4 digits on AC.
Range Accuracy: Accurate from 100% to 0% of range on DC and from 100% to 5% of range on AC.
Polarity: Automatic on DC. Indicated by negative sign (-) when input signal is negative with respects to the + input jack.
Voltage Burden: 0.25 volts on 0.001 mA to 19.999 mA range and 1.6 volts on 20.0 mA to 1.9999 Amps range, typical.
Response Time: Less than 2 seconds maximum.
Maximum Input Protection: 1000 volts (Peak AC + DC) on all ranges, protected by special 1000 volt fuse for high voltage overloads and 2 Amp 3AG fast blow fuse for low voltage overloads.

ENVIRONMENT (all ranges):
Typical Operating Range: 32° to 105°F (0°C to 40°C).
Temperature Range for Rated Accuracy: 60° to 80°F (15.5° to 26.5°C).
Temperature Coefficient: Less than 1/20 of range accuracy per °C from 21°C.
Storage Range: -15° to 150°F (-25° to +65°C).

RESISTANCE (LO POWER OHMS): Five automatic ranges, 00.01 ohms to 199.99 ohms, 200.0 ohms to 1.9999 K ohms, 2.000 K ohms to 19.999 K ohms, 20.00 K ohms to 199.99 K ohms and 200.0 K ohms to 1.9999 megohms.
Accuracy: 0.3%, ±4 digits on all ranges.
Range Accuracy: Accurate from 100% to 0% of range.
Maximum Voltage Across Unknown: 0.2 volts DC.
Response Time: Less than 2 seconds maximum, including autoranging.
Maximum Input Protection: 2000 volts (DC + Peak AC) on all ranges, fuse protected by 1/16 amp fast blow fuse.

RESISTANCE (HI POWER OHMS): Six automatic range, 0.1 ohms to 1.9999 K ohms, 2.000 K ohms to 19.999 K ohms, 20.00 K ohms to 199.99 K ohms, 200.0 K ohms to 1.9999 megohms, 2.000 megohms to 19.999 megohms and 20.00 megohms to 99.99 megohms.
Accuracy: 0.3%, ±4 digits on all ranges except 20.00 to 99.99 megohms, 1.0% ±4 digits.
Range Accuracy: Accurate from 100% to 0% of range.
Maximum Voltage Across Unknown: 2.0 volts DC on all ranges except 10 volts at 100 nA DC on 20.00 to 99.99 megohms.
Response Time: Less than 2 seconds maximum, including autoranging.
Maximum Input Protection: 2000 volts (DC + Peak AC) on all ranges, fuse protected by 1/16 amp fast blow fuse.

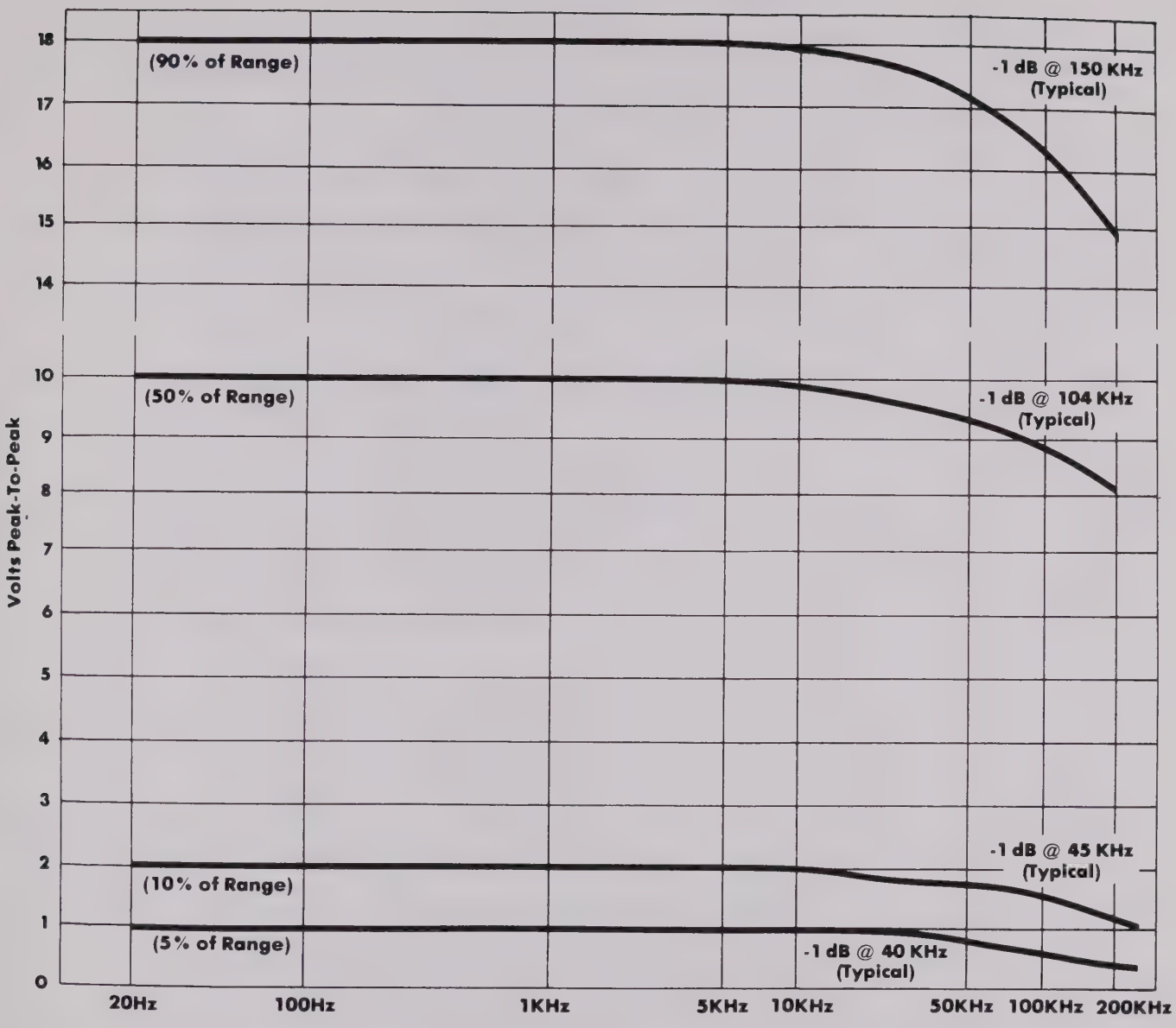
GENERAL

Display: 0.5", 7 segment red LED, selectable 4½, 4 or 3 digits of display on all functions except dB. DB automatically selected, -43 dB to -14 dB, 2 digits and -13.9 dB to +62.2 dB, 3 digits.
Range Indicators: dB, mA, A, Ω, KΩ, MΩ, mV, V, and KV automatically selected by microprocessor. Peak and null arrows selected by PEAK & NULL pushbutton switch, controlled by internal circuit as to which arrow lights.
Negative Sign: Automatic, indicates when DC volts or current is negative with respects to the + input jack.
Overrange Indication: Flashing 88.8 on 3 digits and flashing 88.88 on 4 and 4½ digits of display.
Microprocessor Thinking Time: Less than 2 seconds maximum on all functions, indicated by rolling dashes across display.
Maximum Common Mode Voltage (maximum common lead may float above meter chassis): 1500 volts (Peak AC + DC) between negative lead and third wire ground (case).
Fuses:
Line: Thermal fuse built into power transformer.
Ohms: 1/16 Amp, 3AG fast blow.
Current: 2 Amp, 3 AG fast blow and special 2 Amp 1000 volt fuse for excessive voltage input.
Electrical: All solid-state including microprocessor and memory ICs.
Power: 105 to 130 volts AC, 35 watts typical.
Mechanical: Vinyl covered aluminum case, brushed aluminum handle that also serves as a tilt bail and molded pastic bezel.
Size: 4" x 8" x 11.5" (10.16 x 20.32 x 29.21 cm.)
Weight: 7.75 lbs. (3.56 Kg.)

ACCESSORIES

Supplied Accessories: TP222 X10 Transient Protection Probe, one red test lead with probe, one red test lead with alligator clip, and one black test lead with alligator clip.
Optional Accessories: DBA220 X10 Low Level AC amplifier to increase sensitivity on AC voltage measurements to 0.1 mV and dB, functions to -63 dB. HP200, 50 KV High Voltage Probe to increase DC voltage measurements to 50 KV, DP213 Demodulator Probe to aid in troubleshooting RF circuits, and CS223, 20 amp current shunt to increase current measuring capabilities to 20 amps on AC and DC.

"Design and specifications subject to change without notice."



Frequency response of peak-to-peak ranges as percentage of ranges used. Voltage at left for 0-20 volt range. For 200 volt range, multiply by 10 and for 2 KV range, multiply by 100 for actual voltages.

CONTROLS

1. Digital display, displays value of measured voltage, current, resistance or dB. Negative sign appears when measured quantity is negative.

2. LED range indicators, individual LED lamps light up to show magnitude of measurement for any function.

dB: Lights when Function switch (4) is in the dBm or dBP position.
mA: Lights when measured current is in milliamps.
A: Lights when measured current is in Amps.
Ω : Lights when measured resistance is in Ohms.
KΩ : Lights when measured resistance is in kilohms.
MΩ : Lights when measured resistance is in megohms.
mV: Lights when measured voltage is in millivolts.
V: Lights when measured voltage is in volts.
KV: Lights when measured voltage is in kilovolts.

3. Peak & Null arrows, light up according to the direction a voltage, current, or resistance is changing. + lights when the measured quantity is increasing and - lights when the quantity is decreasing.

4. Function switch, used to select the type of measurement to be made.

5. POWER ON, pushbutton to turn the AC power to the DVM56 on or off.

6. OHMS & dBP ZERO pushbutton, used to zero out the lead resistance when the Function switch (4) is set to OHMS Hi Power or OHMS Lo Power or to establish a new 0 dB reference when the Function switch is in the dBP position.

7. PEAK & NULL pushbutton, used when peaking or nulling a voltage, current, or resistance. Indicated by the peak and null arrows (3) in display area.

8. RANGE HOLD pushbutton, used to lock the DVM56 into specific range for easier measurements where similar voltage, current, or resistances are to be measured.

9. Display Pushbuttons:

9A. 4½ digit button depressed when maximum resolution of the full 4½ digits is required on the digital display (1).
9B. 4 digit button depressed when only 4 digits of resolution are required on the digital display (1) to eliminate different resolution at range changes.
9C. 3 digit button depressed when only 3 digits of resolution are required on the digital display (1) for noisy or erratic signal measurement.

10. Test Lead Jacks, + jack for the high or positive potential and an - for the low or common potential.

ON REAR OF DVM56

11. 15 Volt accessory jack for powering optional DBA220 X10 AC amplifier when used with the DVM56.

12. Fuse compartment, contains the fuses and the spare fuses for the OHMS and Current protection.

13. Fuse compartment cover.

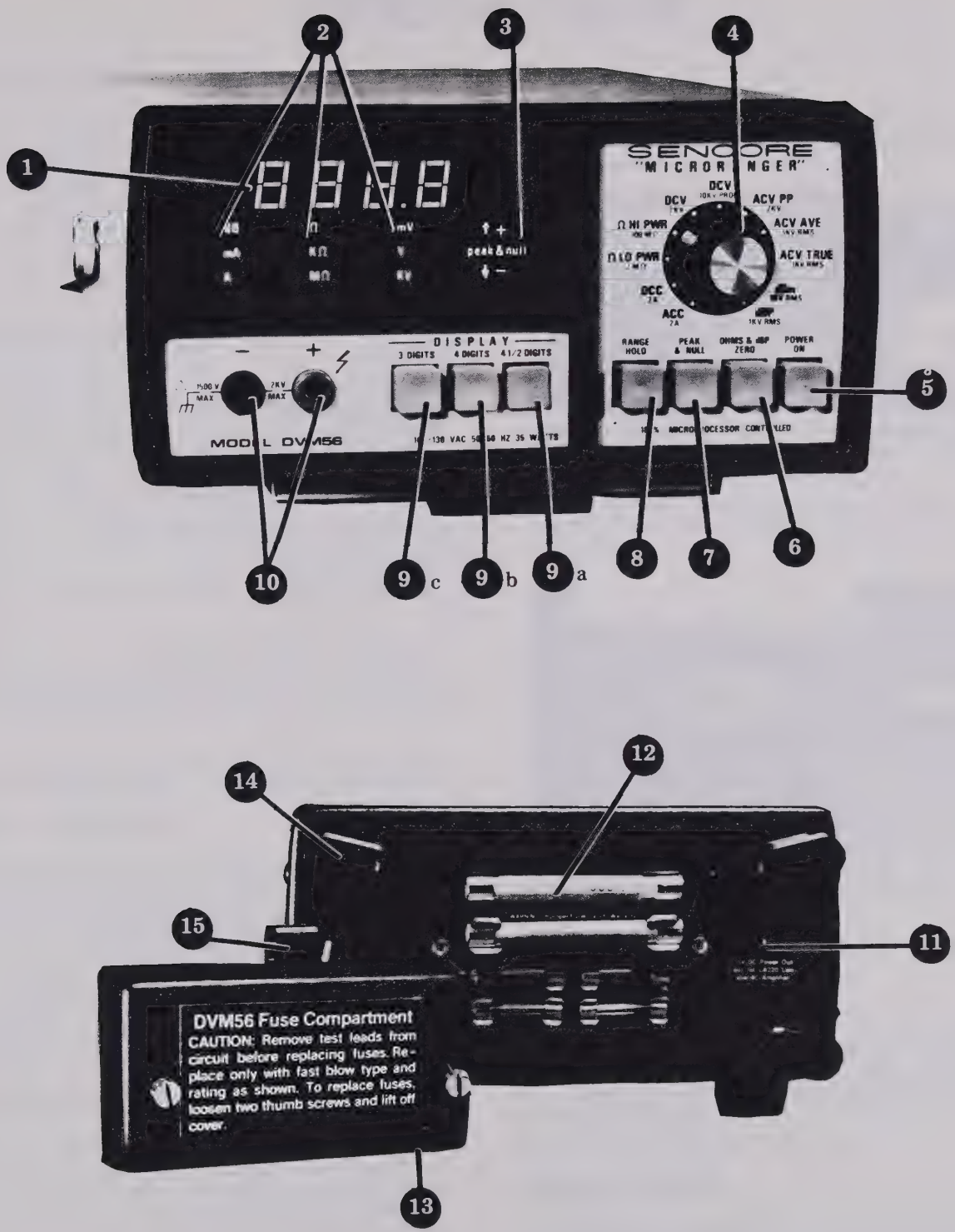
14. AC line cord wrappers.

15. Probe clip: Used to mount TP222 when not in use.

Accessories (not shown):

Supplied Accessories:
TP222, 10 KV Transient Protection Probe
Red test lead with alligator clip
Black test lead with alligator clip
Red test lead with test probe

Optional Accessories:
HP200, 50 KV High Voltage Probe
DP213, Demodulator Probe
DBA220, X10 Low Level AC Amplifier
CS223, 20 Amp AC or DC Current Shunt



11
12
13
14
15
DVM56 Fuse Compartment
CAUTION: Remove test leads from circuit before replacing fuses. Replace only with fast blow type and rating as shown. To replace fuses, loosen two thumb screws and lift off cover.

Fig. 1 — Location of controls and features of the DVM56.

OPERATION

INTRODUCTION

Before using your DVM56 "MICRORANGER" for the first time, take a few minutes to read through the operations and applications section of this manual to acquaint yourself with the features of the DVM56. Once you are familiar with the general operations, most measurements can be performed with the information on the front panel. A general guideline is also provided on the pull out drawer on the bottom of the DVM56. This pull out drawer provides range information, fuse check, and other points that may require referring to from time to time.

POWER CONNECTION

The DVM56 "MICRORANGER" operates from 105 to 130 VAC, 50 to 60 Hertz power line. If 210 to 230 VAC operation is required, the unit may be modified (at additional cost) by the Sencore Service Department, 3200 Sencore Drive, Sioux Falls, S.D. 57107.

To operate the DVM56 from the AC power line:

1. Connect the AC line cord to a 117 VAC outlet (220 VAC for modified units).

2. Depress the POWER ON pushbutton to its latched "in" position.

3. The DVM56 is immediately ready to measure voltage, resistance, current, or dB. If precise measurements are to be made, the DVM56 should be allowed to operate for at least 10 minutes to allow the circuits to stabilize.

4. To turn the DVM56 off, depress the POWER ON pushbutton to unlatch and release the button from the latched "in" position.

POWER OUTAGES

On brief power outages or interruptions of the AC power line, the DVM56 will return to normal operation with the exception that the OHMS and programmable dB functions will have to be rezeroed. There are a few rare occasions when the interruption is very brief and the DVM56 may lock into a non-valid state. The display may show all blinking 8's, random numbers and symbols, or other unusual combinations or the display may go completely blank. If any of these symptoms occur, simply turn the DVM56 off for 2 seconds and then turn it back on to reset the microprocessor circuits.

FUSE REPLACEMENT

AC FUSE: The DVM56 uses a special thermal fuse in the primary of the power transformer in place of a conventional line fuse. If the power transformer is overloaded, such as by a defect in the power supply or a circuit operating from the supply, the thermal fuse may open and remove the AC voltage from the transformer.

FUSE ACCESS: The ohms fuse and the two current fuses along with spares for each are located in the fuse compartment on the rear of the DVM56. To gain access to the fuses for replacement:

1. Unplug the DVM56 line cord from the AC outlet and disconnect the test leads from the circuit being tested.

2. Loosen the two thumb screws on the rear fuse compartment. The screws are captivated and will remain with the compartment cover.

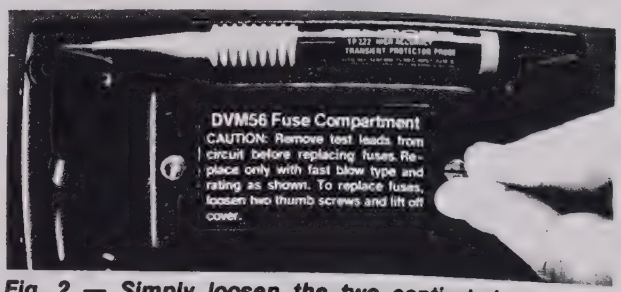

DVM56 Fuse Compartment
CAUTION: Remove test leads from circuit before replacing fuses. Replace only with fast blow type and rating as shown. To replace fuses, loosen two thumb screws and lift off cover.

Fig. 2 — Simply loosen the two captivated screws to remove the cover to the fuse compartment to expose the protection fuses and spare fuses inside.

3. Remove the cover the expose the fuses. Replace the blown fuse with a spare fuse and insert a new spare fuse in the spare fuse holder.

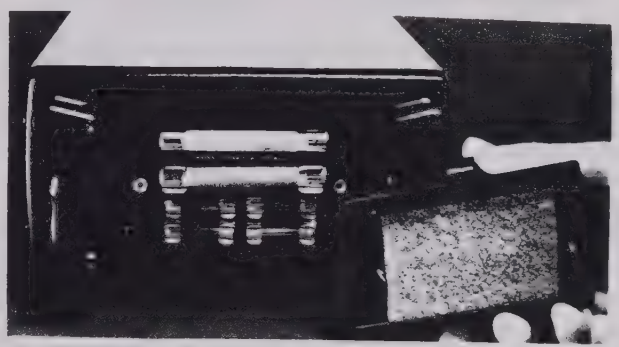


Fig. 3 — Spare fuses are provided in the clips near the protection fuse. Be sure to keep these spare fuse holders filled.

4. Replace the fuse compartment cover and tighten the thumb screws by hand only.

WARNING

Always replace the fuses in the DVM56 with the exact same type as listed in this manual and on the fuse location label in the fuse compartment. Any other type or current rating fuse may cause internal damage to the unit and will void all warranties.

CURRENT FUSES

Two fuses are used to protect the current function of the DVM56. A standard 2 Amp, 3AG fuse protects against current overloads and special 2 Amp 1000 volt use protects against excessive voltage on the input. Spare fuses are mounted in the clips right next to the protection fuse in the compartment on the rear. Be sure to replace the blown fuse with the same type as listed below or its exact equivalent.

2 Amp 3 AG fast blow type: Sencore part number 44G12.
2 Amp 1000 volt special: Sencore part number 44G22.
(Littlefuse part number 621 001)

OHMS FUSE

A standard 1/16 Amp 3AG fuse protects the Ohms divider from excessive voltage or current. Replace ONLY with a 1/16 Amp 3AG fast blow type, Sencore part number 44G13, or its exact equivalent.

NOTE: When you use a spare fuse to replace a blown fuse, be sure to fill the spare fuse holder. This will save valuable time in hunting up a replacement fuse if the fuse is again blown at some later date.

BLOWN FUSE INDICATION

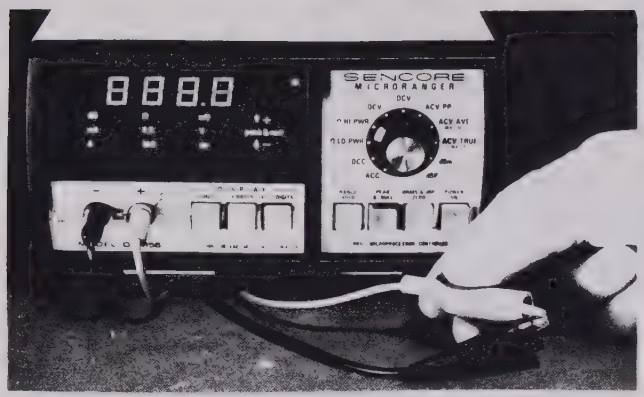


Fig. 4 — When the Ohms or either current fuse is open, the DVM56 will show overrange in the ohms position with the test leads shorted.

Ohms Fuse: Meter will overrange on either Hi Power or Lo Power ohms function with test leads shorted. All other functions will operate normally.

Either Current Fuse: Meter will give a zero reading on all functions regardless of the input except ohms. The meter will overrange on the ohms function with the test leads shorted.

CHECKING THE PROTECTION FUSES

The internal protection fuses used in the DVM56 may be checked using the meter itself without having to remove the fuse from the fuse clip.

To check the internal protection fuses:

1. Remove the rear fuse compartment cover.

2. Connect the black test lead to the - input jack on the front panel.

3. Set the Function switch to either Hi or Lo Power Ohms.

4. Using the black test lead, check the fuses by making contact with the three points shown in the diagram in the sequence shown. If the fuse to which you are connected is good, the DVM56 will read about 10 ohms if the meter has not been zeroed out or 0 ohms if the meter has been zeroed. You can also tell the fuse is good without looking at the digital readout by listening for the clicking of the relays in the autoranging circuits. Any fuse showing flashing 888's is open and should be replaced.

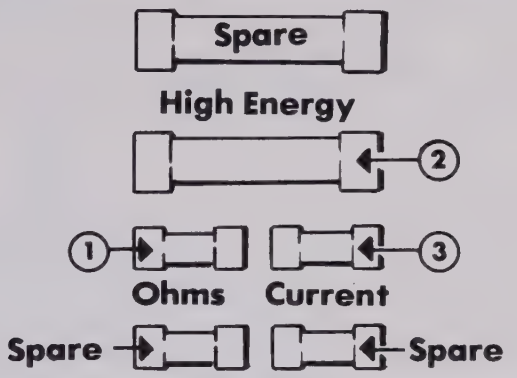


Fig. 5 — To check the protection fuses, simply touch the test lead from the - input jack to the fuses as shown.

AUTORANGING "THINKING" TIME

The DVM56 is a fully autoranged meter on all functions. The microprocessor-controlled circuits select the range that provides the best resolution for each voltage, resistance, or current being measured. Any reading displayed during this range selection process, which takes less than 2 seconds for any function, could possibly mislead the user. The DVM56 displays special "Thinking Bars" during the range selection process to indicate the automatic circuits are operating. The "Thinking Bars" show as a single dash moving from the left to the right on the digital display. The "Thinking Bars" will stop when the proper range has been selected, and the value of the measured value will then be displayed in the digital readout.

The "Thinking Bars" also will indicate the presence of a highly erratic reading which would be meaningless because of a constantly changing display. The microprocessor compares consecutive readings (during autoranging only) and will continue to display the"Thinking Bars" until either of two things occur: 1. The two readings are within 10 digital counts of each other, or 2. The reading has been sampled for more than 5 seconds and the reading is still not stable.

Anytime the "Thinking Bars" continue for more than the normal 2 seconds, simply wait until the microprocessor has determined that the signal will not stabilize. It will be normal for the resulting displayed reading to be erratic after the "Thinking Bars" stop because the input signal is changing in value rapidly.

MEASURING DC VOLTS TO 2 KV

TO MEASURE DC VOLTS

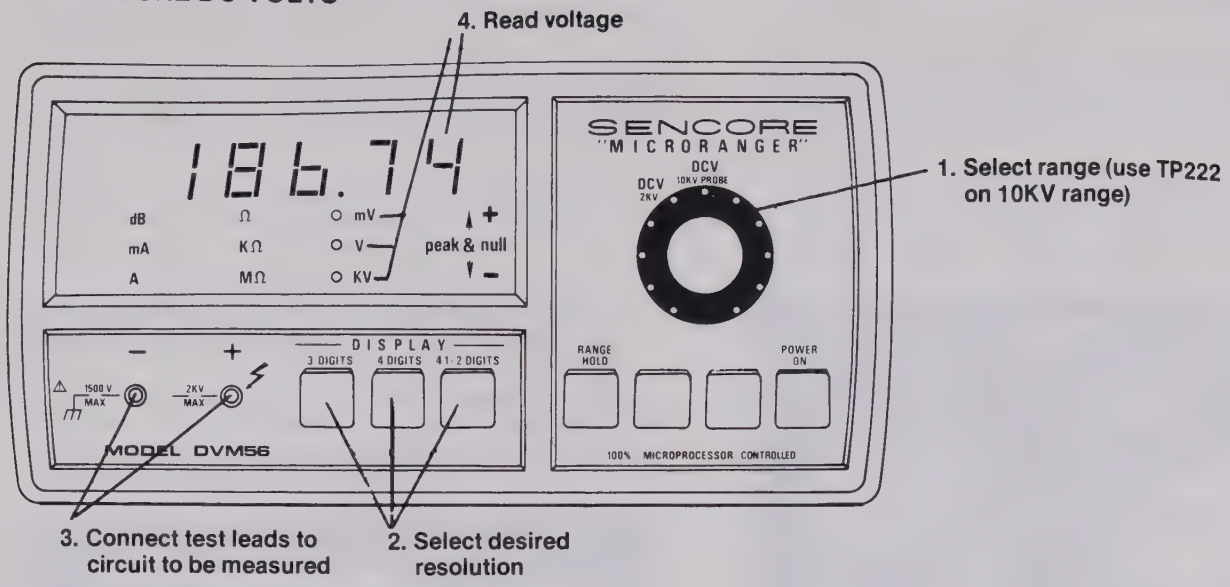


Fig. 6 — Simplified operations for measuring DC volts to 2 KV.

DC voltages up to 2 KV can be measured directly with the DVM56. The polarity is automatically indicated and LEDs will light to indicate if the reading is in millivolts (mV), volts (V), or kilovolts (KV).

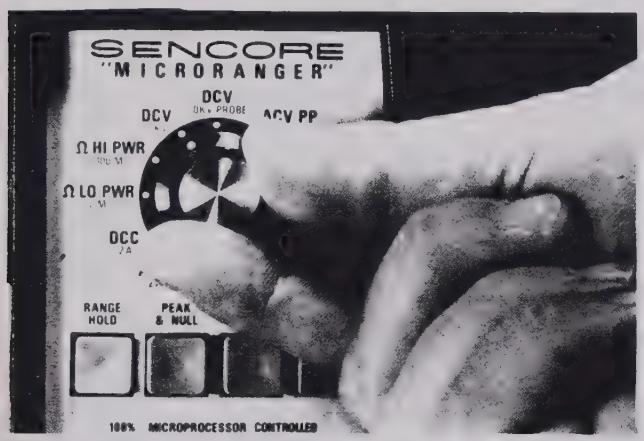


Fig. 7 — When measuring up to 2000 volts DC or using the optional HP200, set the Function switch to the DCV 2 KV position.

To measure DC volts with the DVM56:

1. Set the Function switch to the DCV 2 KV position.

2. Select the desired display resolution of 4½, 4, or 3 digits.

3. Connect the black test lead from the - jack to the common point of the circuit.

4. Insert the Red Test Lead Probe into the + jack and use the probe point to make contact with the point to be measured. Observe the digital display for the reading.

NOTE: The Range Hold button may be used to reduce the response time of the meter if several voltages of approximately the same magnitude are to be measured. See the section in this manual on using the RANGE HOLD button.

NOTE: It is recommended that the TP222 Transient Protector Probe be used any time that DC voltage measurements are made near circuits with high voltages or in circuits with high impedances, such as op amps. The TP222 will add additional protection to the meter and increase the input impedance to 150 megohms for ten times less loading on the circuit being measured.

MEASURING DC VOLTAGES TO 10 KV OR IN HIGH IMPEDANCE CIRCUITS WITH THE TP222 TRANSIENT PROTECTOR PROBE

The special TP222 10 KV probe supplied with the DVM56 is used to extend the DC volts measuring capability to 10 KV, protect the meter against transient voltages, and increase the input impedance to 150 megohms. The 150 megohm input impedance reduces meter loading effects in high impedance circuits and provides virtually zero capacitive loading of the circuit being measured. The accuracy of the TP222 is 0.5%, which is adequate for most measurement applications.

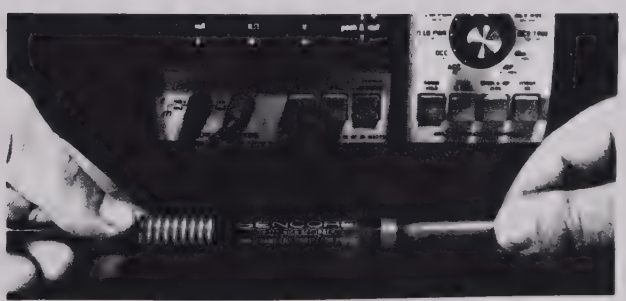


Fig. 8 — The TP222 slips over the end of the regular test probe to increase the input impedance to 150 megohms and the DC voltage measuring capabilities to 10 KV.

To use the TP222 to measure voltages:

1. Set the Function switch to the DCV 10 KV PROBE position.

2. Select the desired display resolution, 4½, 4, or 3 digits.

3. Slip the TP222 over the end of the regulator test probe making sure the probe point is firmly seated in the TP222 connector.

4. Connect the black test lead from the - jack to the common point of the circuit to be measured.

5. Connect the red test lead probe with the TP222 attached to the + input jack and use the TP222 to make contact with the point to be measured.

NOTE: The decimal will be automatically placed in the correct position for a direct readout of the measured voltage when the function switch is in the DCV 10 KV PROBE position.

MEASURING DC VOLTAGES TO 50 KV WITH THE OPTIONAL HP200 PROBE

The use of the optional HP200 50 KV High Voltage Probe allows DC voltages as high as 50,000 volts to be safely measured. The reading on the DVM56 is simply multiplied by 100 (with a 2% accuracy) by adding two zeros to the meter readout.

Fig. 9 — The optional HP200 fits over the end of the regular test probe and increase the measuring capabilities to 50,000 volts.

WARNING

Do not attempt to perform any high voltage testing until you have completely read and understood the following warnings and instructions.

1. **Never attempt to measure more than 2000 volts without the use of the HP200 High Voltage Probe.** To do so may (a) damage the DVM56, (b) damage the equipment under test, and/or (c) cause a severe shock hazard to the operator.

2. **If the common lead should become detached** during a high voltage measurement, immediately remove power to the circuit under test. **Do not touch the lead, the meter, or the HP200 until the power has been removed,** as there is a possibility of a severe shock hazard. Before continuing with the test, be sure the DVM56 is functioning properly.

3. **If the DVM56 probe should become detached from the HP200,** immediately remove the power to the circuit under test. **Do not touch the HP200** until the high voltage has discharged, as there is the possibility of a severe shock hazard.

4. **If the HP200 must be held during a test,** do so with extreme caution. Hold the probe only by the black portion behind the discs. Be sure the ground connection and probe are firmly attached.

5. **Remove power before disconnecting the HP200 from the circuit.**

To measure a DC voltage to 50 KV:

1. REMOVE POWER from the equipment in which the high voltage is to be measured.

2. Plug the DVM56 test probe into the back of the HP200 probe. BE SURE THAT THE PROBE TIP IS SECURELY SEATED.

3. Select the DCV, 2 KV position of the Function switch.

4. SECURELY ATTACH the black common lead from the DVM56 to the ground, chassis, or common point of the high voltage circuit to be measured. BE SURE THAT THIS LEAD CANNOT BECOME DETACHED DURING THE HIGH VOLTAGE MEASUREMENT.

5. Connect the HP200 to the high voltage point to be measured so that the probe DOES NOT HAVE TO BE HELD during measurement. If this is not possible, hold the probe only by the black handle portion for safety, as shown.

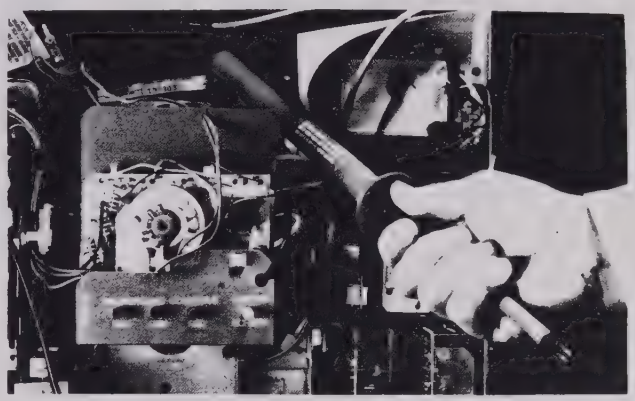


Fig. 10 — The HP200 should be connected to the circuit so that you do not have to hold on to it, but if this is not possible, only hold it by the black handle as shown.

6. Apply power to the equipment under test.

7. Multiply the readout of the DVM56 by 100 to obtain the value of the high voltage being measured. For example, a reading of 300 indicates a voltage of 30,000 volts.

8. REMOVE POWER from the equipment under test before detaching the HP200 and the common lead.

MEASURING AC VOLTAGES

TO MEASURE AC VOLTS

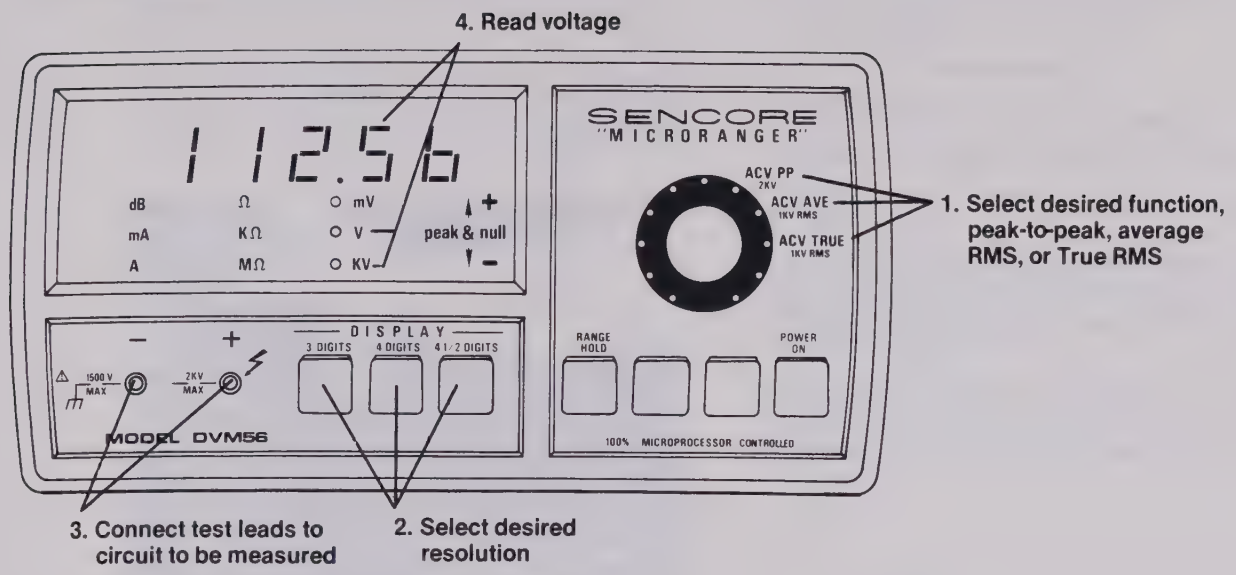


Fig. 11 — Simplified operations for measuring AC voltages.

AUTO ZERO ON AC VOLTAGE FUNCTIONS

The DVM56 has automatic zeroing on all functions. It is normal, however, for the AC voltage functions to show some reading other than zero when the test leads are open. The high sensitivity and high input impedance of the AC functions will read the small amount of AC signal picked up through the air by the test leads. The leads must be shorted together to see the true zero condition.

The readings seen with open test leads will not affect the accuracy of the AC measurements taken in-circuit because the impedance of the circuit being tested will swamp out the AC being picked up by the test leads. Therefore, no special precautions are needed to insure accurate readings that may be affected by a non-zeroed meter.

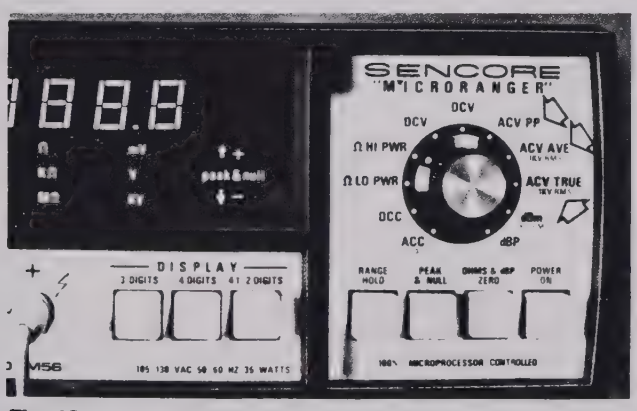


Fig. 12 — The DVM56 allows you to make any one of the three types of AC voltage measurements with the flick of the Function switch.

MEASURING AC VOLTS AVERAGE RMS

The DVM56 allows you to measure AC voltage in average RMS so that you may compare the voltages found on most schematics with the actual readings taken with the meter. Voltages generally found in the power supply area and AC line voltage are all measured in Average RMS.

To measure AC volts in Average RMS:

1. Set the Function switch to the ACV AVE 1 KV RMS position.

2. Select the desired display resolution, 4½, 4, or 3 digits.

3. Connect the black test lead from the - input jack to the circuit common point.

4. Connect the red test lead with the probe to the + jack and use the probe to make contact with the point to be measured. Observe the digital display for the voltage reading and the range indicators that will indicate if the voltalge is in volts (V) or kilovolts (KV).

NOTE: If the AC voltage being measured is not a sine wave, the readings will not truly indicate the measured signal. It is recommended that the AC Volts True RMS or Peak-to-Peak functions be used to measure the voltage.

NOTE: If a series of similar value voltages are to be measured in sequence, the Range Hold button may be used to lock the DVM56 into the desired range and reduce the meter response time. See the section on USING THE RANGE HOLD FUNCTION in this manual.

MEASURING AC VOLTS TRUE RMS

The DVM56 measures the True RMS value of an AC voltage regardless of the shape or complexity of the waveform. RMS (Root Mean Square) is also called "effective" because it produces the same heating effect as a similar value of DC voltage. To measure True RMS AC voltage:

1. Set the Function switch to the ACV TRUE RMS position.

2. Select the desired display resolution, 4½, 4, or 3 digits.

3. Connect the black test lead from the - jack to the circuit common point.

4. Plug the red test lead probe into the + jack and use the probe to make contact with the test point to be measured. Observe the digital display for the voltage reading. The range will light up indicating if the measured voltage is in volts (V) or kilovolts (KV).

NOTE: If a series of similar value voltages are to be measured in sequence, the Range Hold button may be used to lock the DVM56 into the desired range and reduce the meter response time. See the section on USING THE RANGE HOLD FUNCTION in this manual.

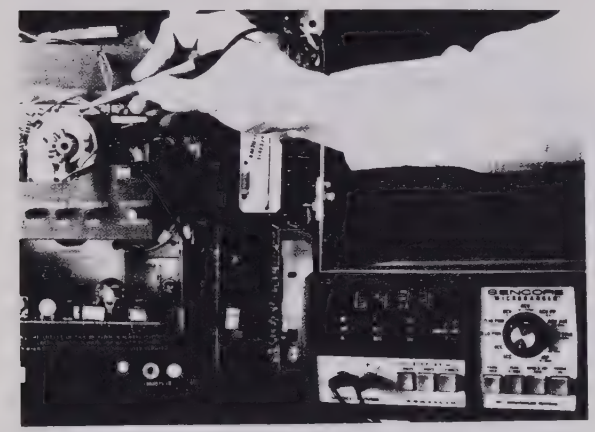


Fig. 13 — The DVM56 True RMS function is needed to measure the CRT filament voltage on the new color sets using scan-derived CRT filament to be sure that the tube is getting the right voltage.

MEASURING AC VOLTS PEAK-TO-PEAK

The DVM56 "MICRORANGER" measures the true peak-to-peak voltage of the AC signal, regardless of the complexity of the waveform. The peak-to-peak function may be used in place of an oscilloscope for signal tracing in circuits where you are only interested in amplitude.

To measure AC Volts Peak-to-Peak:

1. Set the Function switch to the ACV PP position.

2. Select the desired display resolution, 4½, 4, or 3 digits.

3. Connect the black test lead from the - jack to the circuit common point.

4. Plug the red test lead probe into the + jack and use the probe to make contact with the test point to be measured. Observe the digital display for the voltage reading. The LED range indicators will light up indicating if the measured voltage is in volts (V) or kilovolts (KV).

NOTE: If a series of similar value voltages are to be measured in sequence, the Range Hold button may be used to lock the DVM56 into the desired range and reduce the meter response time. See the section on USING THE RANGE HOLD FUNCTION in this manual.

MEASURING dB REFERENCED TO 600 OHMS

TO READ dBm

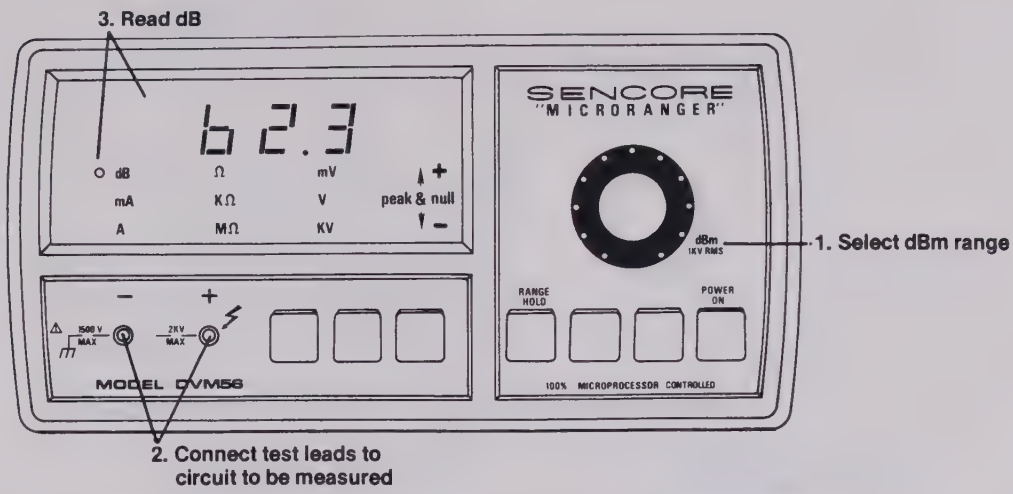


Fig. 14 — Simplified operations for dB measurements using the 1 mW into 600 ohm standard.

The DVM56 has two dB measurement functions to convert True RMS readings to dB readings in audio. The first dB function, dBm, uses the industrial standard 0 dB reference point of 1 milliwatt into 600 ohms (0.7746 volts RMS). The second dB function, dBP, is a programmable function that allows you to program any 0 dB reference that you may need into the microprocessor by simply depressing the OHMS & dBP ZERO pushbutton.

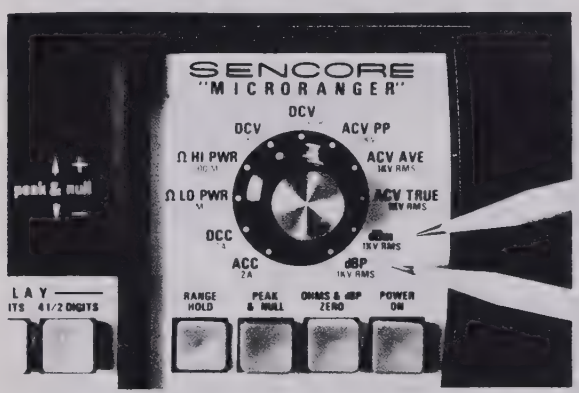


Fig. 15 — The DVM56 allows you to measure dB with either of two functions: The industrial standard of 1 mW into 600 ohms or a reference of your choosing programmed into the microprocessor.

The display resolution is automatically selected by the microprocessor. The display will show two digits from -43 dBm to -15 dBm and 3 digits from -14.9 dBm to +62.2 dBm. If the programmable dBP reference is used, the change in digits will occur at 0.13 volts RMS. The resolution is reduced at lower dB readings to prevent calculation errors. The dBm equivalent of .13V, for example, is -15.5 but .12V equals -16.2, and .11V equals -17.0. The DVM56 shows these readings as -15, -16, and -17 respectively for an accurate indication of the actual converted dBm reading. When the signal is below the -43 dBm level, or there is no input signal, the display will show a —.- reading, indicating that there is no signal or not enough signal to register with any degree of accuracy.

To measure dBm:

1. Set the function switch to the dBm position.

2. Connect the black test lead from the - input jack to the circuit common point.

3. Connect the red test lead probe from the + input jack to the point to be measured. Read the True RMS value converted to dBm on the digital display.

USING THE PROGRAMMABLE dB FUNCTION

TO MEASURE dBP

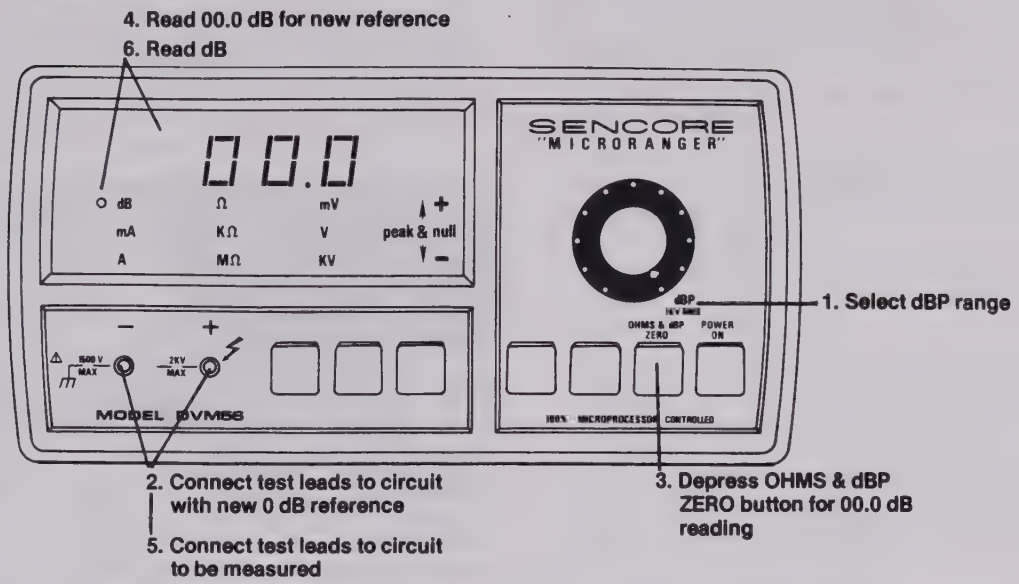


Fig. 16 — Simplified operations for programming and measuring dB with a new 0 dB reference.

The programmable dB function (dBP) allows any 0 dB reference point to be programmed into the microprocessor memory. This allows any reference besides 1 milliwatt into 600 ohms to be used for comparison or allows the dB gain or loss of a stage to be easily determined as the microprocessor does all of the gain calculations for you.

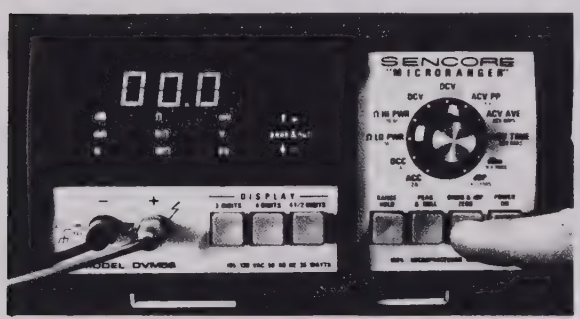


Fig. 17 — To program the microprocessor for a new dB reference, connect the test leads to the desired AC voltage and depress the OHMS & dBP ZERO pushbutton until the display shows a 0 dB reading.

The dBP function is calibrated to the dBm reference when the DVM56 is first turned on. The dBP and dBm functions will, therefore, read the same until the dBP function is reprogrammed. Likewise, the dBP function will return to the dBm calibration if power is interrupted to the DVM56. The signal value programmed into the dBP function will otherwise remain as the 0 dB reference point as long as power is supplied to the meter.

To use the dBP function to program a new 0 dB point:

1. Select the True RMS function of the DVM56 and connect it to an adjustable AC voltage source.

2. Adjust the voltage source until the digital readout shows the desired 0 dB reference voltage.

3. Switch the Function switch to the dBP position and press the OHMS & dBP ZERO button until the display shows a 00.0 readout. The new dB reference is now programmed into the microprocessor memory.

For example, if you wish to use 1 volt as a reference to compare to service literature referenced to "dBv" readings, adjust the voltage source until the displays shows 1 volt RMS. You may use any waveshape to supply this reference signal as the TRUE RMS function will show the actual RMS value.

Then switch to the dBP function and press the OHMS & dBP ZERO button. All dB readings will then be referenced to 1 volt when the Function switch is moved to the dBP position. The dBm function will still be referenced to 1 mW into 600 ohms which allows two separate dB references to be used.

To use the dBP function to determine stage gain or loss:

1. Connect the red test lead to the test point to be used as the reference (the input terminal of a stage in most cases) with the black common lead connected to the circuit common test point.

2. Select the dBP function and hold the OHMS & dBP ZERO button until the display shows 00.0 dB.

3. Move the probe to the output of the stage. The display will show the dB voltage gain or loss. Gain figures will be positive, and loss figures will be negative.

MEASURING LOW LEVEL SIGNALS WITH THE (OPTIONAL) DBA220 LOW-LEVEL X10 AC AMPLIFIER

The DBA220 optional AC amplifier is used with the DVM56 "MICRORANGER" to increase the measuring sensitivity by a factor of ten on signals below 200 millivolts. The DBA220 can be used on any AC voltage or dB function of the DVM56 to measure low-level signals. The DBA220 should be used whenever the signal level drops below 100 millivolts to obtain a more accurate reading of the circuit voltage.

Fig. 18 — The optional DBA220 X10 Low Level AC amplifier simply plugs into the input jacks on the DVM56 to increase the AC voltage measuring sensitivity by 10 times or adds 20 dB to the dB measurements.

To use the DBA220:

1. Plug the test leads from the DBA220 into the test lead jacks on the front of the DVM56, red lead to the + jack and the black lead to the - jack.

2. Connect the power lead from the DBA220 to the power output jack on the rear of the DVM56.

3. Plug the regular test leads from the DVM56 into the input jacks on the DBA220.

4. Use the test leads to measure the low-level circuit voltage. Read the results on the digital display of the DVM56 and divide the reading by 10, or simply move the decimal one place to the left, for the actual voltage.

NOTE: Do not use the DBA220 where the input signal level will be greater than 200 millivolts as the amplifier will overload and give inaccurate readings.

The DBA220 increases the sensitivity of the DVM56 by multiplying the input signal by 10, which is equal to a 20 dB gain. To obtain the actual signal level measured, the voltage readings on the DVM56 must be divided by 10 and the dB readings must have the 20 dB subtracted from the readings displayed. For example, if the voltage reading on the DVM56 was 1.87 volts using the DBA220, divide by 10 to get the actual input voltage of .187 volts or 187 millivolts. If the dB reading was -2 dB, the 20 dB must be subtracted from the display reading: -2 - (20) = -22 dB.

MEASURING RESISTANCE

TO MEASURE OHMS

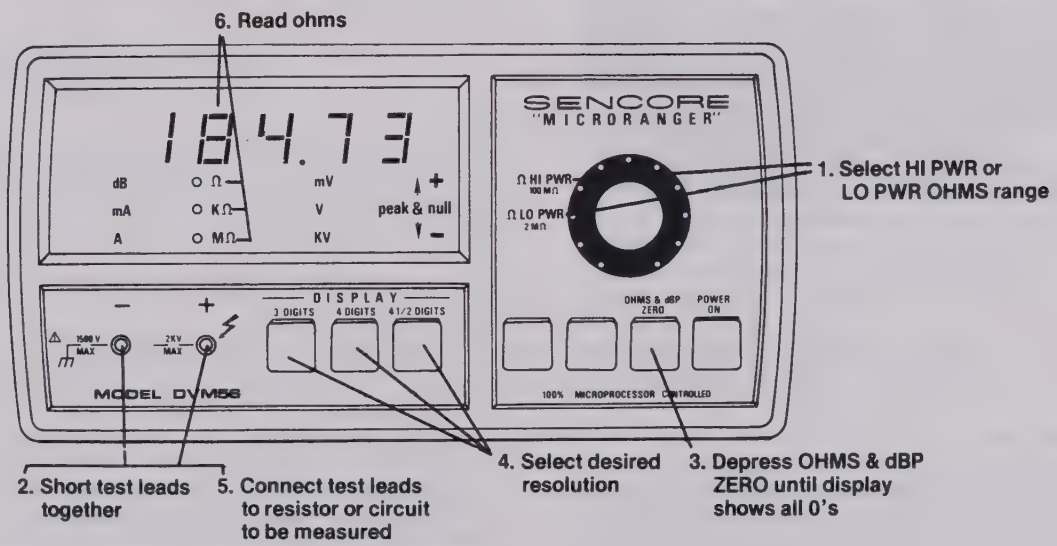


Fig. 19 — Simplified operations for measuring ohms.

DECIDING WHETHER TO USE HI OR LOW POWER OHMS

The DVM56 has two types of resistance measuring functions. The Hi Power Ohms function applies a higher reference voltage than the Lo Power function, which results in semiconductor diode junction conduction. The general rule to remember when selecting one or the other function is that the Hi Power function is used when measuring resistances out-of-circuit and the Lo Power function for in-circuit measurements with the power to the circuit removed. There are, however, other differences to remember when measuring extremely high or low value resistors.

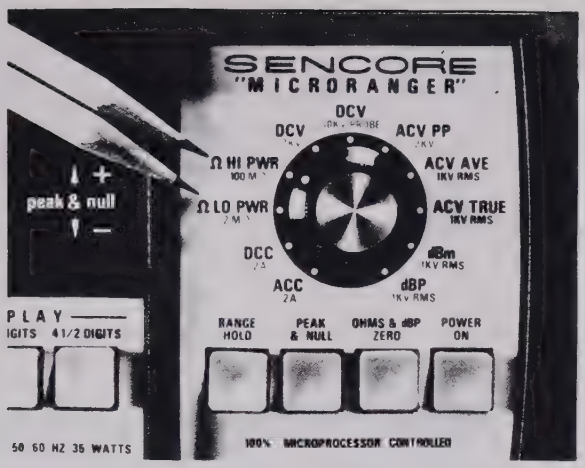


Fig. 20 — The DVM56 provides both LO POWER and HI POWER ohms functions for measurements of resistors both in- and out-of-circuit.

The Lo Power function reads low value resistors (below 200 ohms) with one more digit of resolution than high power. If, for example, the 4½ digit resolution button is pressed, the Lo Power function will show resolution to 0.01 ohms, while the Hi Power function will read to only 0.1 ohms.

The Lo Power function, on the other hand, is limited in its upper range to 2 megohms because higher resistance values would pick up AC signals which would result in erratic readings. The Hi Power function will read resistance values to 100 megohms as it has two additional high voltage ranges. The Hi Power function must be used to measure any resistors in the 2 to 100 megohm range.

MEASURING RESISTANCE WITH LO POWER OHMS

The Lo Power Ohms function of the DVM56 provides only 0.2 volts DC across the unknown resistance. This low voltage will prevent the semiconductor junctions from conducting and changing the resistance readings when checking in-circuit. To measure resistance with the Lo Power Ohms:

1. Set the Function switch to the OHMS LO PWR position.

2. Select the desired display resolution, 4½, 4, or 3 digits. 4½ and 4 digits provide a resolution of 0.01 ohms on low value readings and 3 digits provides a resolution of 0.1 ohms.

3. Plug the test leads into the + and - jacks and short the leads together. With the leads shorted, the display will read about 10 ohms, which is the value of the test leads, fuses, and protection resistors. Depress the OHMS & dBP ZERO pushbutton and hold it in until the display shows a zero readout. The DVM56 will now automatically subtract the lead resistance from all the resistance measurements.

4. Connect the unknown resistance to the test leads. Read the value of resistance on the display and the correct multiplier from the range LED: Ohms (Ω), kilohms (ΩK), or megohms (MΩ).

NOTE: The display will show a flashing 8.888 with 4½ or 4 digit display or 8.88 with 3 digits with the test leads open or an unknown resistance larger than 2 megohms.

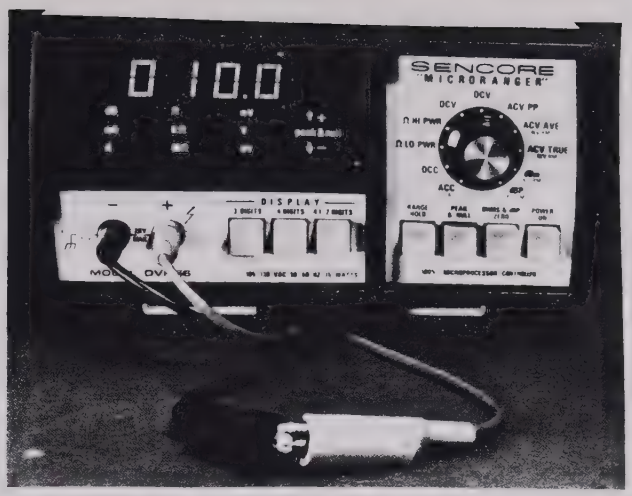


Fig. 21 — The DVM56 will display the resistance of the leads, protection resistors, and fuses before it is zeroed out with the OHMS & dBP ZERO pushbutton.

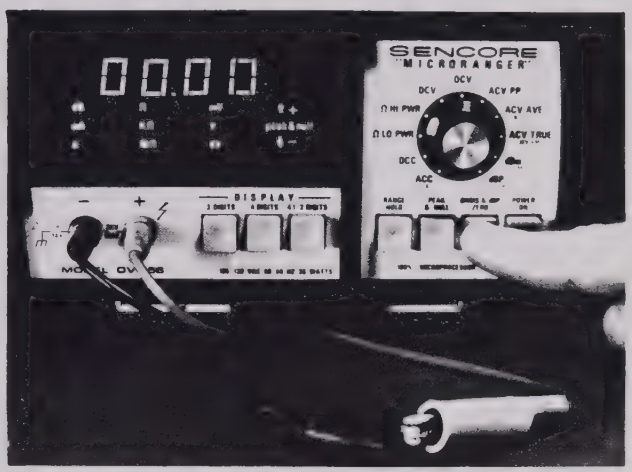


Fig. 22 — When the DVM56 test leads are shorted and the OHMS & dBP ZERO pushbutton is depressed, the display will read 00.00 ohms and cancel the test lead resistance from all resistance readings.

MEASURING RESISTANCE WITH HI POWER OHMS

The Hi Power Ohms function of the DVM56 provides 2.0 volts across the unknown resistance on all ranges except the 20 to 100 megohm range which uses 10 volts. The 10 volts will not damage solid-state devices, however, because the current is limited to .1 microamps. This higher test voltage causes diode and transistor junctions to conduct for front to back leakage checks. This function should not be used to check in-circuit resistances in solid-state circuits as the conduction of the solid-state junctions may cause resistances to read lower than their actual resistance. To measure resistance using the Hi Power Ohms function:

1. Set the Function switch to the OHMS HI PWR position.

2. Select the desired resolution of the display: 4½, 4, or 3 digits. 4½ and 4 digits will provide a resolution of 0.1 ohms on the low scale and 3 digits will provide 1.0 ohm resolution.

3. Connect the test leads to the + and - jacks and short them together. With the test leads shorted, the display will read about 10 ohms, which is the resistance of the test leads, fuses, and protection resistors. Depress the OHMS & dBP ZERO pushbutton and hold it in until the display shows zero. The DVM56 will now automatically subtract the lead resistance from all measurements.

NOTE: With the test leads open, the display will show flashing 888 for 3 digits or 888.8 for 4½ and 4 digits.

NOTE: The RANGE HOLD function may be used on the resistance measurements if all the resistance values are similar or within the same meter range. See the section on using the RANGE HOLD button in this manual.

NOTE: The Lead Zero procedure needs only be performed once each time DVM56 is turned ON. Zeroing the leads automatically zeros both Hi and Lo Power Ohms.

MEASURING AC AND DC CURRENT TO 2 AMPS

TO MEASURE AC OR DC CURRENT

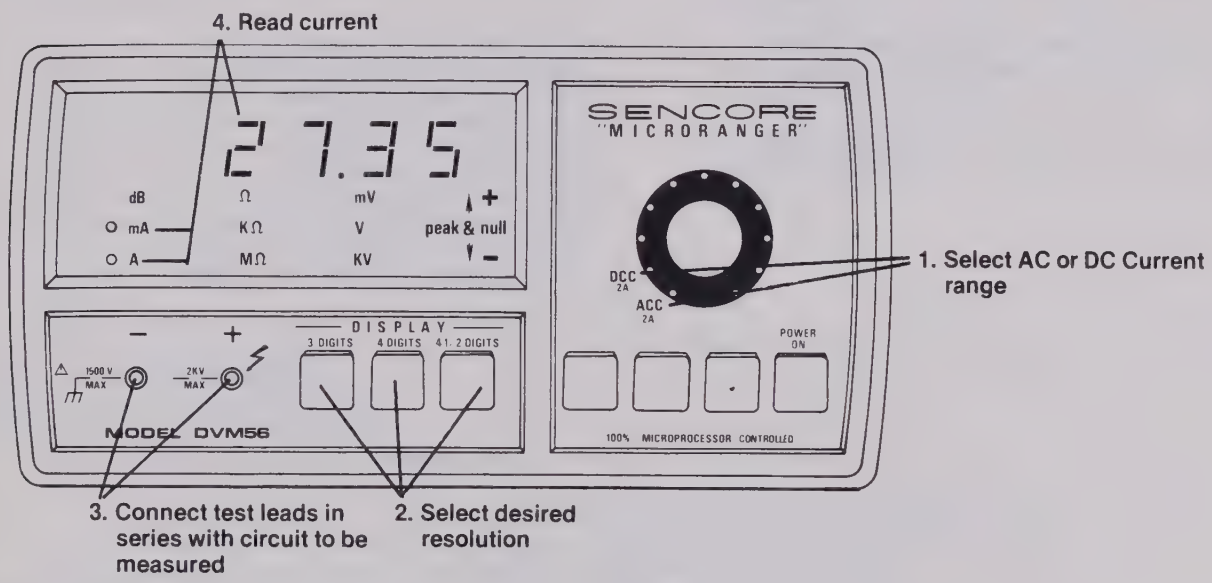


Fig. 23 — Simplified operations for measuring AC and DC current.

The DVM56 can measure DC current up to 2 amps through the front panel jacks. The current reading will be in milliamps (mA) or in amps (A) and be read directly on the digital display.

WARNING

Observe extreme caution when measuring the current of high voltage circuits as the full circuit potential will be present at both ends of both test leads. Never attempt to measure the current in a circuit with a potential higher than 1500 volts between the common lead and third wire ground as the input limits of the meter may be exceeded.

To measure DC current:

1. Turn off the power to the circuit to be measured.

2. Set the function switch to the DCC position.

3. Select the desired display resolution: 4½, 4, or 3 digits.

4. Connect the test leads from the DVM56 in series with the circuit to be measured. The + input jack to the most positive point and the - input jack to the most negative point of the open circuit.

5. Turn the power to the circuit on and the current reading will be displayed on the digital readout. If the test leads are reversed, the negative sign (-) will appear in front of the reading indicating that the current is negative with respects to the + input jack. This means that the + jack is connected to the most negative point and the - jack to the most positive point.

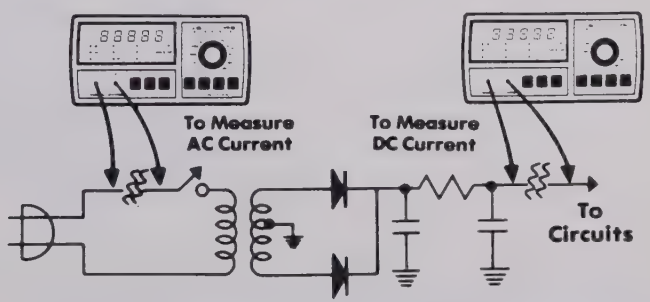


Fig. 24 — To measure either AC or DC current, simply break the proper line and insert the DVM56 in series with the circuit.

MEASURING AC OR DC CURRENT TO 20 AMPS WITH THE OPTIONAL CS223 SHUNT

The (optional) CS223 20 Amp Current Shunt may be used to extend the current measuring capabilities of the DVM56 to 20 Amps AC or DC. The design of the CS223 is unique in that the shunt is placed close to the circuit and the test leads are then run to the meter. This minimizes measurement errors that are common to most current shunts caused by lead or contact resistance.

The maximum voltage drop across the CS223 is only 0.2 volts at 20 amps to prevent excessive voltage changes in low voltage circuits, such as digital power supplies. The current is read by measuring the voltage drop across the shunt and converting the resulting reading to current by simply moving the decimal point two places to the right. AC currents are read using either the Average or True RMS functions, and DC currents are read using the DC Voltage function.

WARNING

Use exteme caution when measuring current in high voltage circuits as the full potential will be present at both the input and the output terminals of the CS223 and the DVM56 test leads. Never attempt to measure the current of any circuit with a potential of more than 1500 volts above the third wire ground, as the input limits of the meter may be exceeded. The CS223 should never be used to measure currents in circuits that may exceed 20 amps as excessive heating may destroy the precision shunt resistor wire.

To use the CS223 20 Amp Current Shunt with the DVM56:

1. Remove power to the circuit under test and open the circuit to be measured.

2. Connect the two heavy clip leads of the CS223 between the open circuit points. The clips are color-coded if DC current polarity is important; red to the most positive point and black to the most negative.

3. Connect the black test lead of the DVM56 to the black output terminal and the red probe or clip lead to the red output terminal.

4. Select the DCV 2KV, ACV AVE or ACV TRUE function of the DVM56, depending upon the type of current to be measured, and apply power to the circuit to be tested.

5. Note the resulting voltage reading and multiply by 100 for the actual current. For example, a reading of .1 volts represents a circuit current of 10 amps.

6. Remove power to the circuit under test before disconnecting the current shunt leads.

MAKING PEAKING OR NULLING ADJUSTMENTS

TO USE PEAK AND NULL FUNCTION

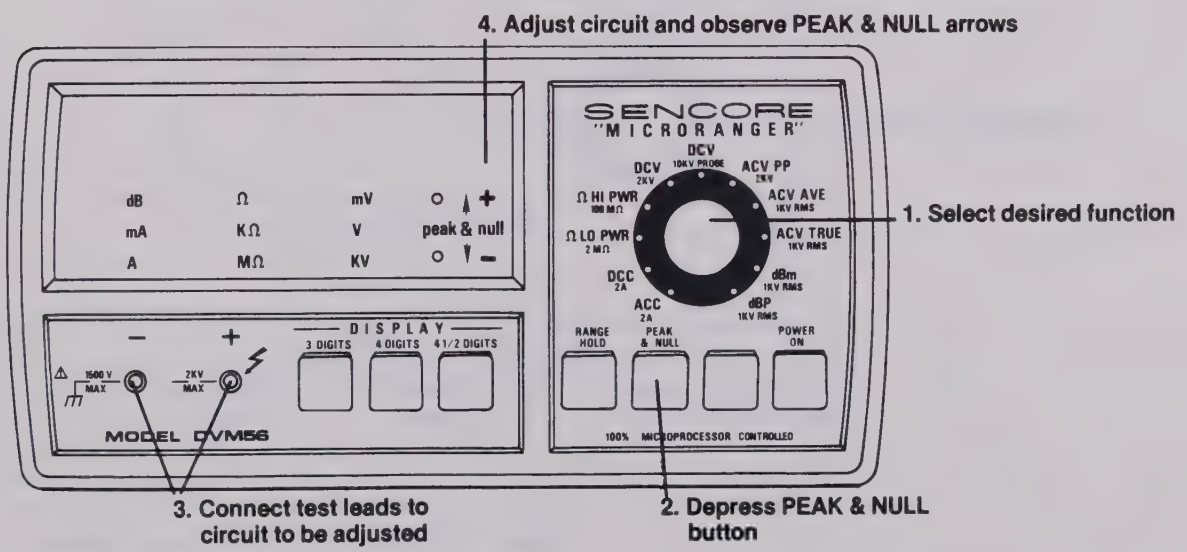


Fig. 25 — Simplified operation to measure Peak & Null.

Digital meters are usually slow to use when adjusting a control that requires a voltage or current to be set to a maximum or minimum value. The digital meter must convert different input signals to digital readouts, which requires a delay of about .2 seconds for each reading. Some meters have an additional analog meter movement to facilitate the adjustment of these controls. The DVM56 eliminates the added expense of an analog meter circuit with the use of two special "Peak and Null" LEDs. These LEDs respond instantly to a change in the input signal to indicate whether a signal is increasing or decreasing in amplitude.

When making an adjustment that must be peaked, the + LED will remain the brightest as long as the input signal is increasing

in value. As soon as the absolute peak is reached, the two LEDs will reverse in intensity indicating that the signal has stopped increasing and has begun to decrease in value. Similarily, when adjusting a control for a null, the - LED will be the brightest until the voltage has reached the null and begins to increase in value. Again, the intensities of the two LEDs will reverse.

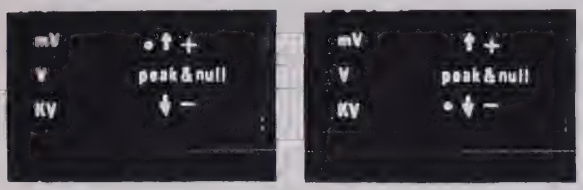


Fig. 26 — When using the Peak & Null function, the + LED will light when the measured quantity is going positive, and the - LED will light when the measured quantity is going negative.

To use the Peak and Null function:

1. Set the Function switch to the desired function to be measured: volts, current, or resistance.

2. Depress the PEAK & NULL pushbutton to its in or locked position.

3. Adjust the circuit for its peak or null:

a. If the circuit is to be peaked, watch the PEAK & NULL LEDs and turn the circuit adjustment in the proper direction to light the + LED. Continue to turn the adjustment in the same direction until the intensity of the two LEDs reverse.

b. If the circuit is to be nulled, watch the PEAK & NULL LEDs and turn the circuit adjustment in the proper direction to light the - LED. Continue to turn the adjustment in the same direction until the intensity of the two LEDs reverse.

Repeat the procedure by turning the adjustment in the opposite direction to confirm that the true peak or null point has been reached.

NOTES:

1. If the adjustment will cause the DVM56 to go through a change in ranges, use the RANGE HOLD button to hold the meter in the highest range. If the DVM is allowed to autorange, the PEAK & NULL circuits will require a few seconds to stabilize after the range change.

2. The PEAK & NULL circuits are not designed for adjustments that require a setting to zero, such as the discriminator of an FM receiver. These adjustments are not really nulls, but adjusting to a set voltage (zero volts in this case). Use the digital readout to make adjustments requiring an absolute zero setting.

USING THE RANGE HOLD FUNCTION

TO USE THE RANGE HOLD FUNCTION

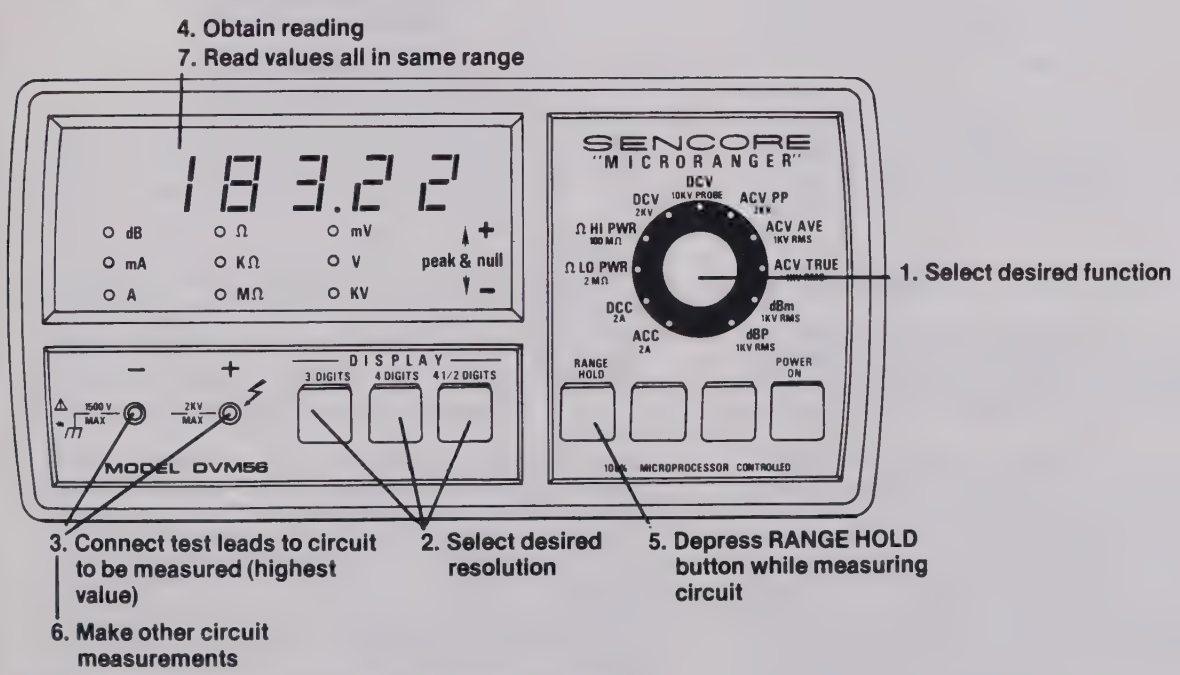


Fig. 27 — Simplified operation for the RANGE HOLD function.

The DVM56 may be locked into a specific range when a series of measurements of voltage, current, or resistance are to be made, which are all similar in value. This will reduce the response time of the meter and prevent the microprocessor from hunting up the range each time a measurement is made. The Range Hold feature may be used at any time or released at any time by merely depressing the RANGE HOLD button.

To use the RANGE HOLD button:

1. Select the desired function to be measured, voltage, current, resistance, or dB.

2. Select the desired display resolution: 4½, 4, or 3 digits. The display will be 3 digits automatically when measuring dBm or dBP.

3. Connect the black test lead from the - jack to the common point of the circuit.

4. Plug the red test lead probe into the + jack. Place the probe at a point in the circuit or across the resistor that will give the highest reading on the meter of the readings that will be taken. For example, the B+ point of the circuit.

5. With the probe connected to the highest reading point, depress the RANGE HOLD pushbutton to its in or locked position. Proceed to make the measurements required.

6. To release the RANGE HOLD function, simply depress the RANGE HOLD button to its off or out position. This will convert the DVM56 back to its autoranging mode.

NOTE: Depressing the RANGE HOLD pushbutton with no input to the DVM56 will lock the meter on the lowest range of any function.

DISPLAY RESOLUTION

The DVM56 "MICRORANGER" provides you with a choice of three display resolutions: 4½, 4, or 3 digits. 4½ digits are used when the DVM56 is used to calibrate other test equipment or when lab accuracy is needed. The 4 digit display is used in most engineering labs, and the 3 digit when troubleshooting. The basic accuracy of the DVM56 is not changed when the display resolution is changed from 4½ to 4 or 3 digits. The resolution accuracy is changed from 0.75% to only 0.175% on DC as you decrease the display resolution from 4½ to 3 digits.

Fig. 28 — The maximum number of digits that will be displayed in the 4½ digit position is 19999, in the 4 digit position 9999, and in the 3 digit position 999.

When the 4½ digit display is used, the last digit may change or "bounce" with the change in voltage or current in the circuit being measured. This is a normal condition due to the regulation of the power supply and circuits being measured. If the regulation is 0.01% or better, the last digit will not change. If the last digit is not required or the changing digit is distracting, simply convert the DVM56 to a 4 or 3 digit meter. The DVM56 gives you the best of both lab accuracy and servicing speed.

When the DVM56 is used to measure voltages below 1.00 volts using the 4½ digit display, it may appear to decrease to a four digit display. The last half digit only occurs between measurements of 1.0 and 1.9999 and multiples thereof. The DVM56 does not have a range below 1.00 volts, but the microprocessor moves the decimal point and makes it easier to read the voltages as millivolts rather than parts of a volt. If the voltage is decreased below 100 mV, extra zeros will be added to the front of the reading, for example, a 50 mV level will appear as 050.0. If the level drops below 10 mV, for example 3.5 mV, the readout will appear as 003.5.

MAXIMUM DIGIT DISPLAY: 4½ digits = 19999, 4 digits = 9999, and 3 digits = 999. The half digit occurs between 10000 and 19999.

DECIMAL POINT SHIFT

The DVM56 "MICRORANGER" is a smart ranging digital meter. The DVM56 shifts the decimal point at the end of the decade and not in the middle of the decade as with other autoranging digital meters. For example, the DVM56 shifts the decimal between 9.999 and 10.000 volts. Other autoranging meters shift the decimal at 1.700 and again at 19.99 volts. These meters will actually shift the decimal twice while the DVM56 shifts only once. The DVM56 eliminates this confusing decimal shift during measurements that are found in other autoranging meters. The decimal shift points are at: 999 mV, 9.999 volts, 99.99 volts, 999.9 volts.

OVERRANGE INDICATION

The overrange indication on the DVM56 is flashing 88.88 for 4½ and 4 digits and 88.8 for 3 digits. If the DVM56 shows flashing 8's when the RANGE HOLD button is depressed, the meter is locked into a range below the level being measured. Simply depress the RANGE HOLD button to release the function and eliminate the overrange indication.

When measuring dB, an indication of --- - shows that the signal level is either less than -43 dB or there is no signal at the input to the DVM56. A row of dashes moving from left to right indicates that the microprocessor is thinking and is preparing to display a number on the digital display.

CONNECTING THE DVM56 COMMON ABOVE GROUND

WARNING

When the DVM56 common lead is floated above or below ground potential, use extreme caution to prevent contact with either meter lead. All overload specifications must be observed in reference to the potential applied between the two test leads. DO NOT place the common lead at more than 1500 volts (DC + Peak AC) above or below the common or third wire ground.

The DVM56 common lead may be connected or "floated" to a potential above or below the common ground. For example, between two phases of a three phase wiring system, as long as the 1500 volts (DC + Peak AC) is not exceeded.

TEST LEADS

The DVM56 is supplied with three test leads, two with alligator clips and one test probe. The test probe is designed so that the TP222 supplied with the DVM56 can be easily slipped over the end when making DC voltage measurements.

TP222 10 KV Transient Protection Probe: The TP222 10 KV probe is supplied mounted on the rear of the DVM56 in the special clip. To use the probe, remove it from the clip and slip it over the end of the test probe until the test probe seats firmly into the jack inside the TP222. The TP222 extends the measuring range of the DVM56 to 10 KV DC and increases the input impedance from 15 megohms to 150 megohms. The TP222 also protects the DVM56 against accidental overloads and transient voltages that may be present during testing, such as the spikes on the collector of the horizontal output transistor or in a switching power supply.

NOTE: It is recommended that the TP222 be used at all times when measuring DC voltages. This will insure your safety and prevent accidental damage to the DVM56. The TP222 need only be removed when measuring AC voltages, current, or resistance. The TP222 not only provides additional protection, it increases the input impedance and reduces the capacitive loading on critical circuits during DC voltage measurements.

APPLICATIONS

AC VOLTAGE MEASUREMENTS

AC voltages may be measured in three different ways: the peak-to-peak value, the average value, or the RMS value. Each method will produce a different value reading for the same AC voltage because each uses a different system for converting the AC voltage to a reading on an analog meter or digital display. Let's look at each of the three methods and see how they measure the AC voltage and why they are different.

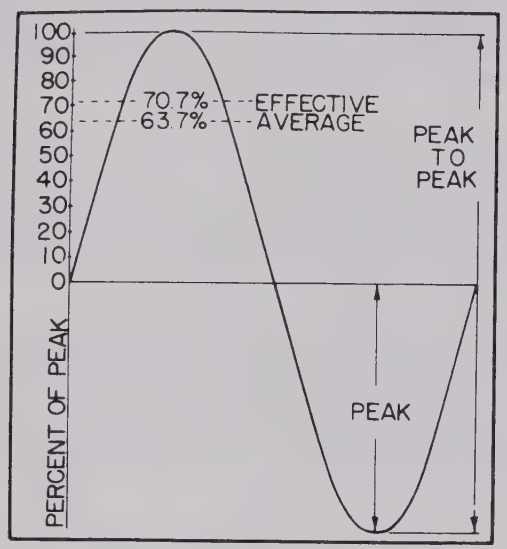


Fig. 29 — A pure sine wave showing the relationship of the RMS and average values in percentages.

PEAK-TO-PEAK: The peak-to-peak value measurement is the value from the maximum positive to the maximum negative peaks of the AC voltage regardless of when they occur. The peak-to-peak value will not change if the shape of the waveform changes, only when the amplitude is increased or decreased. Most peak-to-peak reading meters use a peak detection diode and calibrate the meter or display in twice the peak value to read peak-to-peak.

AC AVERAGE RMS: The average value of an AC voltage is derived from taking the average of all the points along the wave-shape and averaging them together. The average value of a sine wave AC voltage is 63.7% of the peak voltage. The average value is obtained by rectifying the AC voltage and filtering it to DC before it is applied to the display device. Meters using average detection and calibrated to read RMS are accurate only as long as the AC voltage is a pure sine wave.

AC TRUE RMS: The RMS or root-mean-square value of an AC voltage sine wave is 70.7% of the peak value. RMS is often called the "effective" value because it is the quantity that produces the same heating effect as a similar amount of DC voltage. If a meter uses standard diode detection and is calibrated to read RMS, it will only be accurate as long as the AC voltage is a pure sine wave. To obtain the RMS value of other waveforms, a special and costly RMS converter integrated circuit must be used and is why most digital meters do not have the True RMS function.

The peak-to-peak, average, and RMS AC voltage values are all simple percentages of each other as long as the AC voltage is a pure sine wave. When the AC voltage is no longer a sine wave, the relationship becomes more complex as shown in the following chart. The chart compares the peak-to-peak value of some of the more common waveforms to the RMS and average values. Note that the peak-to-peak is always the two extremes of the waveforms regardless of its shape. The RMS and average values, however, depend upon the shape of the waveform. Not only is the shape of the waveform important in the measurement of RMS AC voltages, the difference between the peak and RMS value is also important and is called the crest factor.

The crest factor is the ratio of the peak value compared to the RMS value of the AC voltage. The crest factor increases from 1 for a perfect square wave to about 2.5 for a pulse such as the horizontal keying pulse in a TV set. The width of the pulse and the distance between the pulses are the controlling conditions in the crest factor of a waveform. The true RMS converter used in the DVM56 has a minimum crest factor of 3 so that you will obtain accurate RMS measurements of the pulse waveforms and similar AC voltages that you may measure.

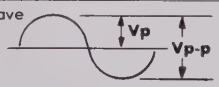
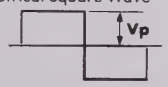
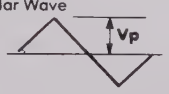
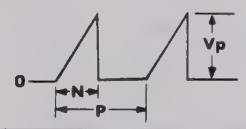
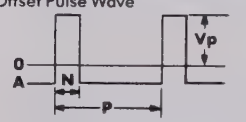
Waveform	RMS Value	Average Value	Crest Factor
Sinewave 	0.707Vp or 0.353Vp-p	0.637Vp or 0.3185Vp-p	1.414
Symmetrical Square Wave 	Vp or 0.5Vp-p	Vp or 0.5Vp-p	1
Triangular Wave 	0.577Vp or 0.288Vp-p	0.5Vp or 0.25Vp-p	1.732
Sawtooth Pulse Wave 	$\sqrt{\frac{T}{3}} \cdot Vp$ $T = \frac{N}{P}$	$0.5T \cdot Vp$ $T = \frac{N}{P}$	$\sqrt{\frac{3}{T}}$ $T = \frac{N}{P}$
Offset Pulse Wave  Vpp = Vp + A	$\sqrt{T} \cdot Vp$ $T = \frac{N}{P}$	$Vp \cdot T + (1-T)A$ $T = \frac{N}{P}$	$\frac{Peak}{RMS}$ or $\sqrt{\frac{P}{N}}$ $T = \frac{N}{P}$

Fig. 30 — The comparison of the various waveforms and how they relate to the peak-to-peak, RMS, and average AC voltages.

WHICH TYPE OF MEASUREMENT SHOULD YOU USE?

Deciding upon which type of AC voltage measurement to use is based upon two important facts. First, is the AC voltage a pure sine wave or a complex waveform, and second, what are the measurements that you must compare taken in, peak-to-peak, average or RMS. Knowing these important points will allow you to determine which type of AC voltage measurement you should make.

If you are comparing the AC line voltage and other AC voltages around a power transformer, they are generally taken in average RMS, and the readings that you take should be in average, too, so that they will correspond. AC voltage readings around electromagnetic and electromechanical devices such as motors, solenoids, and relays should also be in average as these devices are average responding.

RMS values are used where the effective heating value is important, such as in lamps or heating elements. Tube filaments and the new scan-derived CRT filament voltages are also measured in RMS to be sure that they are receiving the proper amount of voltage to generate the correct heat for the cathode. Average readings in these important areas may give misleading results.

Peak-to-peak measurements are used when dealing with complex waveforms, such as video or the deflection signals in a TV set. Here you must know the peak-to-peak value to be sure that there will be enough signal for the proper picture on the CRT or that the CRT raster will be deflected across the full width of the screen. Any time you are dealing with complex waveforms, you will make the AC voltage measurements in peak-to-peak.

MEASURING RESISTORS ABOVE 100 MEGOHMS WITH THE DVM56

The DVM56 allows you to measure resistors up to the unheard of value of 100 megohms using the Hi Power Ohms function. By using an external parallel resistor across the input terminals on the Hi Power Ohms function, you can increase the measuring capability of the DVM56 to 5000 megohms and above. To simplify the procedure, we recommend that you construct an adaptor using a double banana connector with solder terminals (Pamona MDP-ST or H.H. Smith part #1676) with a 90 megohm, 0.25%, ½ watt film resistor (Sencore part #14C27-9007A) soldered across the terminals. The double banana connector allows you to parallel the input with the 90 megohm resistor and still have the test leads free to connect to the unknown resistor.

Fig. 31 — A constructed double banana adaptor and 90 megohm resistor allow you to measure resistance values to 5000 megohms and higher with the DVM56.

To measure resistors above 100 megohms:

1. Construct the adaptor described above and insert the adaptor into the input of the DVM56.

2. Set the Function switch to the Ω HI PWR 100MΩ position. The DVM56 display will now read the value of the 90 megohm resistor.

3. Connect the regular test leads to the input of the adaptor and short the leads together. After the DVM56 has displayed the resistance of the test leads and internal protection resistor (about 10 ohms) depress the OHMS & dBP ZERO pushbutton and hold it in until the display shows 00.00 ohms.

4. Connect the test leads to the resistor to be measured and allow about 2 seconds for the meter reading to settle down. You may then take the reading displayed on the DVM56 and find the value of resistor from the curve supplied or by inserting the reading into the formula below. The curve is based on the 90 megohm resistor and provides readings for resistors up to 3500 megohms. For resistors above this value or if you use a resistor value other than the 90 ohms recommended, use the formula:

$$\text{R unknown in megohms} = \frac{\text{R displayed X 90}}{\text{90 - R displayed}}$$

R displayed = Resistance value displayed on DVM56.
90 = 90 megohms resistor paralleling the input of the DVM56.

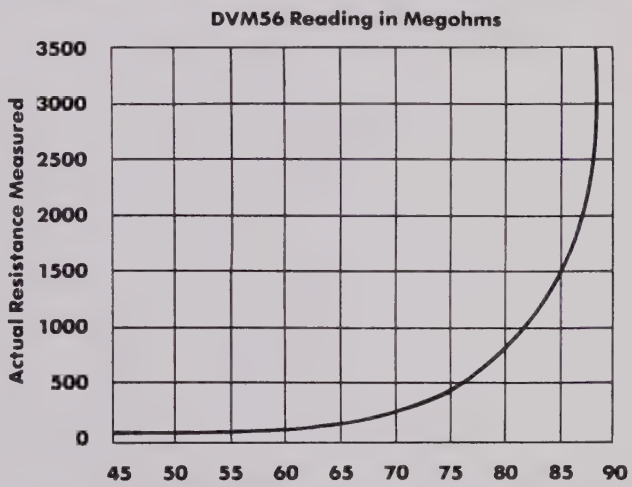


Fig. 32 — The 90 megohms resistor curve showing the values of resistance measured on the DVM56 versus the actual value of resistor being measured.

USING THE PROGRAMMABLE dBP FUNCTION IN AUDIO AMPLIFIERS

The programmable dBP function can be used to speed up signal tracing in both tube and solid-state audio amplifiers. This simple time-saving procedure allows you to measure the individual stage voltage gain in dB without having to add or subtract dBs from the meter reading. Simply set the Function switch to the dBP position and measure the input signal to the amplifier. Depress the OHMS & dBP ZERO pushbutton to set the DVM56 to this voltage as the 0 dB reference. Then measure the output of the first stage and read the voltage gain directly from the display in dB. Then depress the OHMS & dBP ZERO pushbutton again and reprogram the DVM56 to the output voltage of the first stage as the new 0 dB reference. Then measure the output of the second stage and read the voltage gain in dB without having to subtract the first dB reading from the reading displayed on the DVM56.

Repeat this procedure from the input to the output to find the voltage gain of each individual stage in the amplifier. If you work on many of the same make of amplifiers, you should mark the stage gain in dB right on the schematic for reference. In this manner, you will have a quick reference and help reduce your

troubleshooting time the next time you work on a similar chassis.

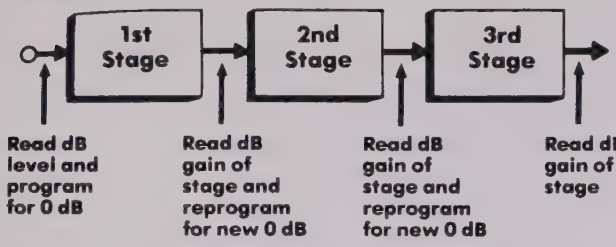

1st Stage
2nd Stage
3rd Stage
Read dB level and program for 0 dB
Read dB gain of stage and reprogram for new 0 dB
Read dB gain of stage and reprogram for new 0 dB
Read dB gain of stage

Fig. 33 — The dBP or programmable dB function can be used to find the gain of the different stages in an audio amplifier without the need of adding or subtracting dBs for faster and easier service.

CHECKING TRANSISTORS AND DIODES

The DVM56 HI PWR OHMS function can be used to check the front-to-back resistance ratio of transistor junctions and diodes. A good transistor junction or diode will show an overrange with the test leads connected in one direction and a resistance reading when they are reversed. A shorted transistor junction or diode will show a low resistance reading in both directions while an open junction or diode will show overrange in both directions.

The DVM56 forward resistance reading will differ slightly from that of an analog meter. The DVM56 will lock in on a higher resistance range due to the conduction of the diode or junction and the autoranging of the microprocessor, generally between 30K ohms and 200K ohms. This high reading does not indicate a defective junction or diode, merely that the DVM56 has locked into a higher resistance range and has converted the voltage drop across the diode to a high resistance reading.

Because the DVM56 resistance function measures the voltage drop across the junction and converts this to a resistance, you may use this to determine if the transistor or diode is a silicon or germanium type. Just simply lock the DVM56 into its lowest resistance range with the RANGE HOLD pushbutton and move the decimal three places to the left to find the voltage drop across the junction being measured.

To determine if the diode or transistor is silicon or germanium:

1. Set the DVM56 Function switch to Ω HI PWR position and short the test leads together.

2. After the reading is displayed, depress the OHMS & dBP ZERO pushbutton to zero the ohms function. Then while the test leads are still shorted, depress the RANGE HOLD pushbutton to lock the DVM56 into its lowest range (0-2K ohms).

3. Connect the test leads to the transistor junction or diode and observe the digital display.

a. A resistance reading of 200 to 300 ohms represents a voltage drop across the junction of 0.2 to 0.3 volts, indicating a germanium junction.

b. A resistance reading of 500 to 700 ohms represents a voltage drop across the junction of 0.5 to 0.7 volts indicating a silicon junction.

By converting the resistance reading to its voltage reading when using the lowest resistance range, you can quickly determine if the diode or transistor under test is silicon or germanium.